Development of Hardware Interface to Generate Electric Power from Parked Electric Vehicle

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Abstract - The growing popularity of electric vehicles (EVs) creates a substantial potential for grid-side power management. Parked EVs can serve as mobile energy storage devices, helping to reduce peak loads and improve grid stability. A suggested hardware interface allows parked EVs to securely and efficiently discharge power back into the grid. The design includes hardware components and communication protocols to ensure that the EV, interface, and utility grid work together seamlessly. Safety concerns are addressed, including bidirectional power flow regulation, grounding, and fault prevention. The interface controls communication between the EV and the grid operator, allowing for more efficient power exchange schemes. The proposed system is simulated in Matlab environment for verification and validation. This research work helps to a more intelligent and sustainable electric system.

Keywords – Wind Energy, Parked vehicle, Matlab, AC to DC, generator

I. INTRODUCTION

The employment of renewable energy sources in the production of power has garnered noteworthy attention owing to their environmental advantages and sustainability. Among the resources that have shown promise for producing electricity are wind and solar energy, which provide a plentiful and clean energy source [1,2]. The creation of power generation systems for stationary automobiles is one creative use of wind energy. While a car is stationary, these systems use wind energy to create electricity. This alternate power source can be used for a variety of tasks, including charging electric cars, running onboard electronics, and maintaining car systems.

The intermittent nature of wind, which results in varying power output, and the requirement for backup energy sources are some disadvantages of wind turbine facilities [3-5]. In addition to causing noise pollution and visual intrusion, turbines can negatively affect the surrounding community. Wildlife is also at risk from wind turbine collisions with birds and bats, among other things. Offshore installations confront corrosion and accessibility issues, in addition to high maintenance and operating expenses. Lastly, the need for infrastructure changes related to wind energy transmission could raise expenses.

On the other hand, the world of transportation is changing due to electric automobiles. Since EVs only run on electricity, as opposed to conventional gasoline-powered vehicles, they have zero emissions out of the exhaust. As a result, our cities will have cleaner air and produce fewer greenhouse gases. EVs also have the benefit of being more economical. EVs are a more appealing option for drivers who care about the environment because they are less expensive to operate than gasoline-powered vehicles. Nevertheless, EVs depend on a network of vital parts to operate, much like wind power plants. High-capacity batteries, electric motors that propel the car, and converters that control the system's electricity flow are a few examples of these. Electric motors store and release electrical energy. To ensure the safe and effective operation of EVs, additional components are also essential.

When electric cars (EVs) are used to generate electricity, the stored electrical energy is transformed into usable power via the inverter and onboard batteries [6]. With the help of this creative strategy, EVs can function as mobile power plants that generate electricity for a range of uses, including events, off-grid power supply, and emergency backup. In addition to delivering extra electricity back into the grid, EVs with bidirectional charging capabilities also facilitate vehicle-to-grid (V2G) services and maintain grid stability [7-9]. This game-changing idea encourages the use of renewable energy sources and expands the uses of electric cars beyond transportation.

The rest of the paper is organized as follows. Proposed embedding and extraction algorithms are explained in section II. Experimental results are presented in section III. Concluding remarks are given in section IV.

II. PROPOSED SYSTEM

The proposed system generates power through the use of a wind power plant and an e-vehicle. Power generation contributes to the decrease of environmental contamination and the effective utilization of resources. In this paper, a novel system architecture that converts wind power to generate clean electricity from a parked electric vehicle (EV) is explored. The vehicle's status is first checked by the system. Subsequently, the user must connect the coupler to the electric vehicle's wheel. The system cannot function in the generation mode unless the user selects the "Generation Mode" option. By selecting it, the EV's electric motor is connected to designated generator terminals and is isolated from the drive train's regular operation. The EV motor and the wind turbine, which is usually mounted on the building's roof, are connected by a sturdy mechanical coupler. The motor may move freely with the wheel assembly owing to the freewheeling configuration, which effectively turns the wheel into a generator. The mechanical energy produced by the turbine rotating due to wind is transmitted down the shaft. Next, to guarantee compatibility with the EV motor, carefully positioned bevel gears change the direction of shaft rotation. The EV motor uses this redirected mechanical energy as its input and is currently running in generator mode. The wind's mechanical energy is thus transformed into electrical energy via the motor. The user has two alternatives to the generated electricity. It offers an easy way to store energy for later use inside the EV's battery, giving the car itself a clean and sustainable power source. An alternative is to send the electricity straight into the electrical grid using a bidirectional power converter. This novel method essentially flips the normal power flow inside the electric vehicle. The car moves forward under typical driving conditions when power moves from the battery to the motor. That power flow is deftly inverted in "Generation Mode," though. The electricity generated by the generator, also known as the active motor, can be stored in the battery or added to the power grid via the bidirectional converter.

III. HARDWARE COMPONENTS

To implement the proposed system, a 2 KW wind turbine must be purchased. An anemometer is employed for sensing the wind speed as well as wind temperature. With this data, the power generation can be calculated. In addition to an AC to DC rectifier, a 12V battery capacity is needed. To convert the generated AC power to DC power, an AC to DC converter is useful. The application must guide the selection of the generator to be used. Converters are required to store the AC power produced by the wind in batteries. Initially, Matlab was used to complete the simulation. The three blades that make up the wind turbine are primarily impacted. The mechanical gearbox system is an essential component in the transfer of the wind turbine's captured rotational energy. Various parts, such as cams, shafts, belts, chains, and shaft layout, can be used in this system, depending on the required efficiency, power output, and shaft arrangement. A mechanical coupling that joins the selected parts to the wind turbine completes the integration process.

IV. RESULTS AND DISCUSSION

The real-time data for wind speed was measured using an anemometer. The data has been sent to the cloud for future analysis. A 2-kW wind turbine is connected to a BLDC generator in Matlab. The generator helps to generate the AC power which is measured using voltage and current measurement. The generated AC voltage cannot be stored directly so it is converted into DC voltage using a rectifier. The rectified voltage is used to charge the battery or we can feed the generated voltage to the grid for its reliability. The matlab Simulink diagram, Figure 1 is shown below for your reference.

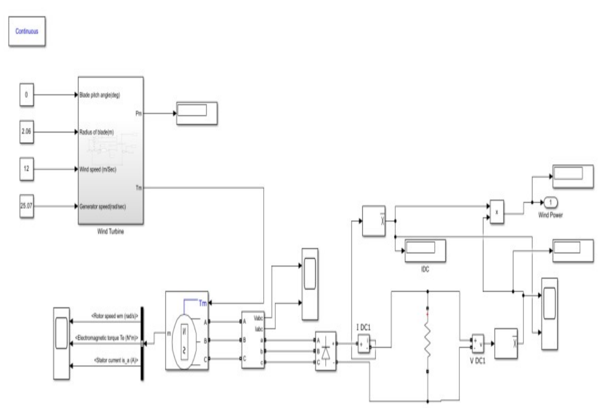

Figure 1. Power Generation Circuit - Matlab

The generator plays a crucial role in generating power. In general, 4 generators are commonly employed in power generation. The efficiency of several generator types is contrasted in the table 1.

Table -1 Comparison of Generators

Generators	Efficiency (%)
Induction Generator	85 – 95
Doubly Fed Induction Generator (DFIG)	90 – 95
Permanent Magnet Synchronous Generator (PMSG)	90 – 98
BLDC Generator	85 - 95

While Permanent Magnet Synchronous Generators (PMSG) and Doubly Fed Induction Generators (DFIG) show efficiencies ranging from 90-98% and 90-95%, respectively, induction generators have an efficiency of 85-95%. The efficiency of brushless DC (BLDC) generators ranges from 85 to 95 percent. These efficiency figures shed light on how well each type of generator performs in different scenarios. The generator's efficiency was varied and the power generated is compared as shown in Figure 2.

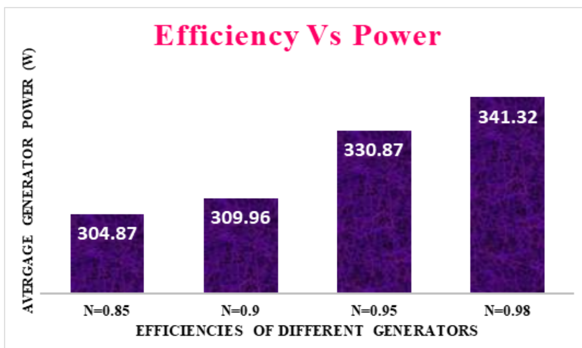

Figure 2. Comparison of Efficiency Vs power generation

As of now most of the e-vehicle uses the BLDC motor in the system. So that BLDC generator has to employed for small application. For implementing large wind mill or plant, PMSG is preferred.

V.CONCLUSION

Using parked electric vehicles to generate renewable energy is a viable strategy. Potential advantages of this technology include decreased dependency on fossil fuels, improved grid efficiency, and financial savings for EV owners. However, more research is necessary because of technical difficulties, financial concerns, and grid integration difficulties. Research aimed at maximizing effectiveness, cutting expenses, and resolving these issues can open the door for broader adoption. With the help of this technology, EVs that are left parked could play a significant role in the clean energy industry in the future.

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